Appendix H

Use of Probability Distributions of the CVOC Plume Length Index as a Reference Frame for Plume Behavior

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The analyses conducted in this study suggest that creation of a Plume Length Index (PLI) through the normalization of plume length by maximum concentration and site mean hydraulic conductivity provides a means for identifying the effects of transformation and partitioning processes on plume behavior. As such, the distribution of PLI may serve as a reference frame for classifying plume sizes. This probability distribution of PLI is shown on Figure H-1. "Typical" plumes fall, by definition, near the 50th percentile of the distribution. PLIs falling into the low-end tail of the distribution would be characterized as "short" for the given environment, based on comparison to other plumes. Conversely, PLIs falling into the high-end tail would be characterized as atypically "long".

This classification scheme may provide a systematic means for identifying anomalous plumes and may be used to quantify the effects of reductive dehalogenation, transport through fractured rock settings, pumping from nearby water supply wells, and other factors which could potentially influence plume length. To test this concept, plume analyses were conducted on 32 plumes from eight sites that were not included in the 65 sites constituting the kernel of the database. These sites were not included in the original analyses because data did not become available until late in the study. As such, these eight sites represent a random sample of environmental conditions in the same manner as any of the 65 sites included in the original analyses.

Individual PLIs by CVOC from each of the eight sites are shown on Figure H-2 along with the PLI cumulative distribution derived from analyses of the original 65 sites (i.e., the kernel population). The logarithms of the PLIs associated with each of the eight sites were compared to those of the original data set using the student's *t*-test as a means for identifying sites featuring plumes that differed significantly (i.e., exceeding the 95% confidence level) from the kernel population. Among the 8 sites, five were characterized by plumes that did not differ significantly from the kernel population in terms of PLI. Two of the sites, Seq. No. 6340001 and Seq. No. 4902, appeared to be characterized by PLIs significantly longer than the kernel population, whereas a single site, Seq. No. 6380006, exhibited significantly shorter PLI. In the case of Site 6380006, strong evidence of reductive dehalogenation exists, with a vinyl chloride plume present along with co-contamination by fuel hydrocarbons. At the only site among the 8 exhibiting strong evidence of reductive dehalogenation, the lower PLI is consistent with the analyses discussed earlier in this report. Contour mapping of CVOC concentration data associated with Site 6340001 (see Figure H-3) reveals that several distinct plumes are discernible in the site database. The plume algorithm (described in Appendix B) was unable to differentiate the individual plumes and interpreted the data as a single continuous plume, resulting in a PLI that is indicative of a distinctly long plume. Normally, the data collection procedures (Chapter 2) would have identified such distinct plumes and labeled them as such, preventing such problems.

Nevertheless, although this example represents an error in the processing of site data in this instance, it does point out the utility in using the PLI distribution as a reference frame for identifying anomalies. In the case of Site 4902, a satisfactory explanation for the atypically long normalized plume lengths could not be found. Given the mean hydraulic conductivity of 1.7 ft/day at this site, the 3,000-ft-long TCE plume length is unusual for the maximum historical concentration of only 350 ppb. It is possible that in this case higher source area concentrations, which would reduce the PLI, may have existed in the past and dispersed or else were not detected by the monitoring well network.

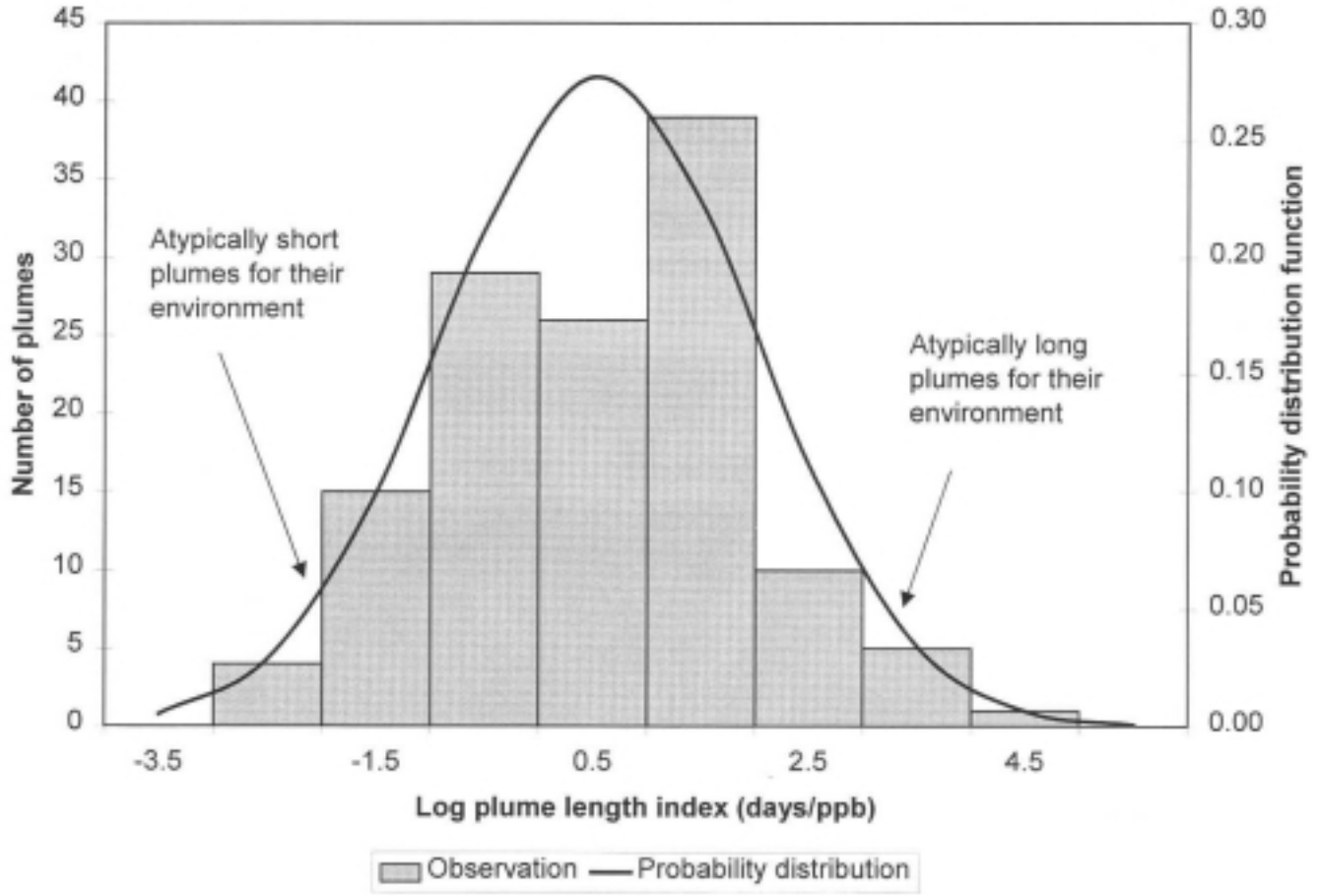

Figure H-1. Histogram and best-fit lognormal probability distribution of CVOC plume length indices (plume length divided by the product of the maximum concentration and groundwater velocity).

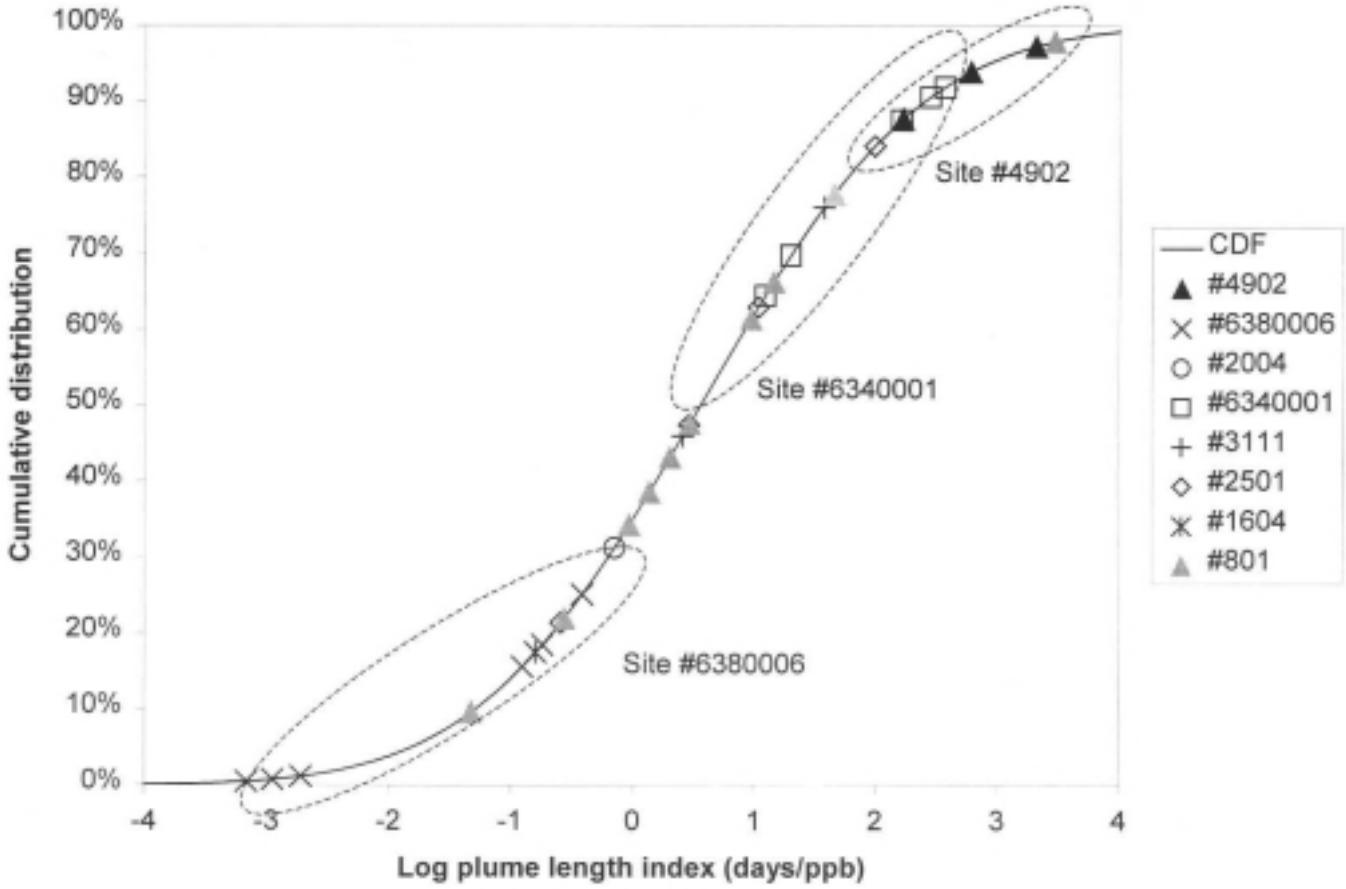

Figure H-2. Plume length indices for 8 test sites beyond the 65 kernel CVOC sites in the data set. The cumulative distribution function (CDF) best-fit to the kernel data set is shown for comparison.

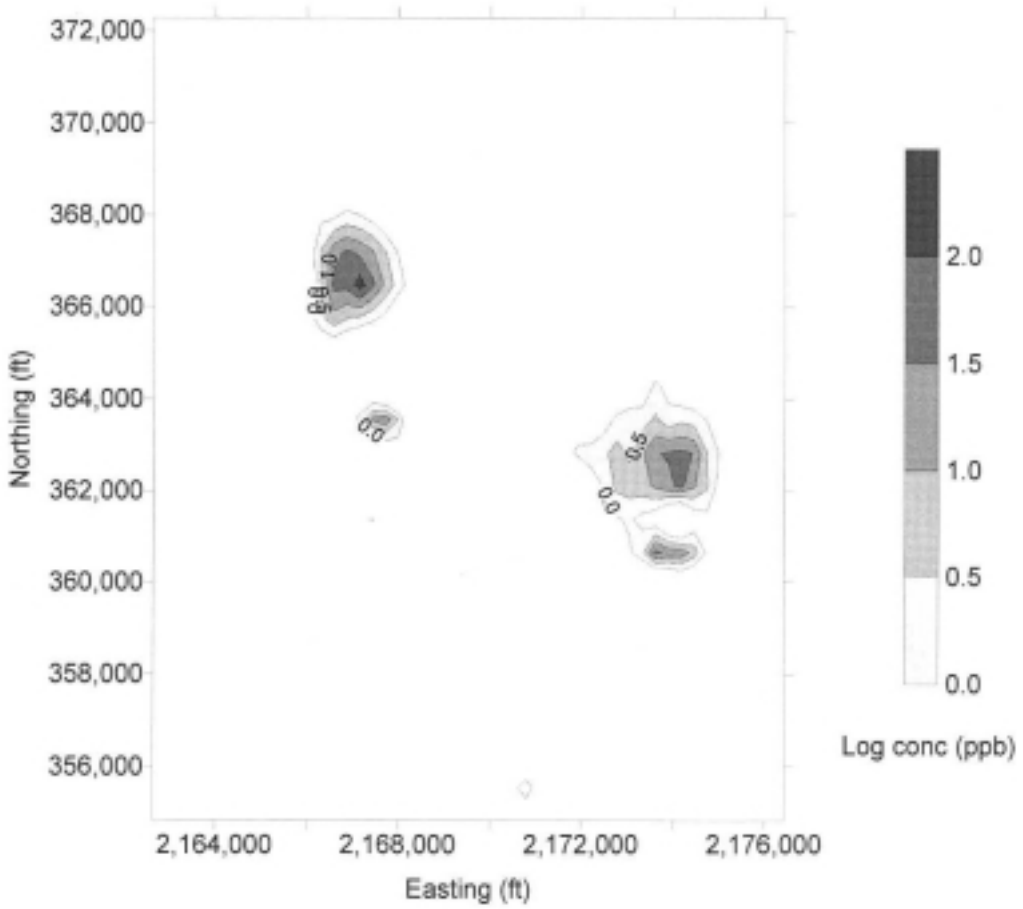

Figure H-3. 1,1-DCE plumes at Site 6340001.